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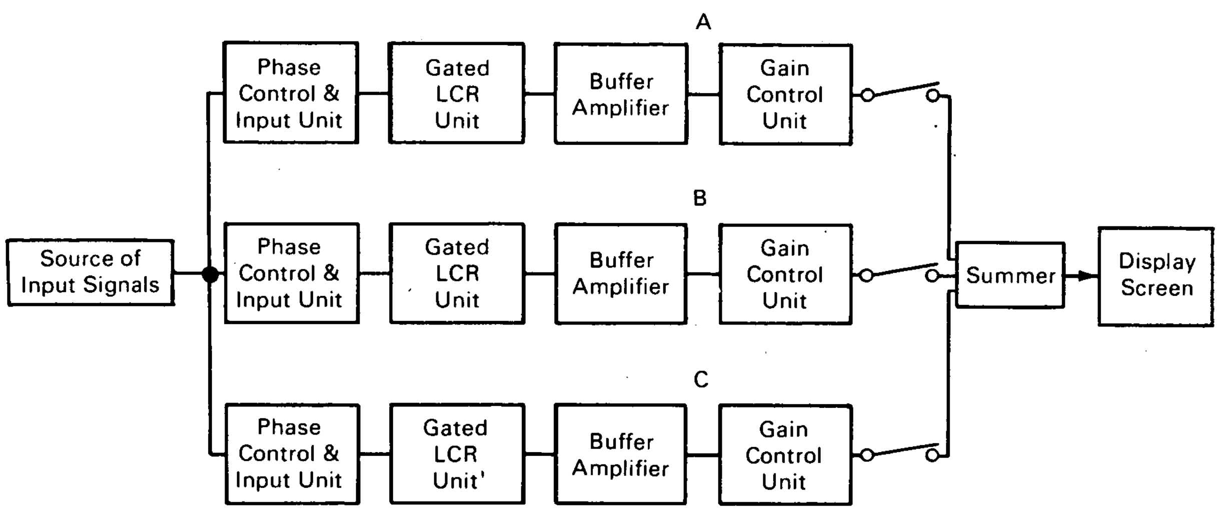
NASA TECH BRIEF

Waveform Simulator Synthesizes Complex Functions



The problem:

In the performance of scientific experiments, the synthesis of a complex waveform or curve which is the sum of two or more simpler functions is sometimes necessary. For proper interpretation or synthesis, the curve must be reduced to its component parts. For example, in the application of radio frequency interferometer techniques in the measurements of plasma wave propagation, when two or more modes at the same frequency but with different wavelengths are present in the plasma, a composite curve is generated which is the sum of two or more exponentially damped sine waves with independent amplitudes, frequencies, damping rates and phases. To interpret such a curve properly, reducing it to its component parts is necessary in order to determine the amplitude, frequency, damping rate and phase relationship of each exponentially damped sine wave. Graphical analysis of such a curve, a technique previously employed, is practical when the case is simple and if the degree of precision required is not particularly high. However, if the case is complicated, or when the required degree of precision is quite high, other techniques must be employed.

Thus, a need exists for a relatively simple apparatus which can simulate a complex curve and can readily determine the parameters of the curve's component parts.

The solution:

A multichannel apparatus as shown in the figure has been designed to produce or simulate a complex curve which can be viewed on an oscilloscope display surface and can be adjusted to match an original complex experimentally produced curve. The displayed waveform is the algebraic sum of two or more damped sine waves whose frequency, amplitude, damping rate and phase parameters are independently

(continued overleaf)

varied by adjusting each sine wave generator. The simulated curve is viewed on the oscilloscope through a transparent tracing of the experimental curve. The parameters of each channel are then varied to synthesize a complex curve which is the best fit to the experimental curve.

How it's done:

A sawtooth input signal is applied to each channel consisting of a phase control and input unit, connected between the signal source and a gated inductance-capacitance-resistance (LCR) unit. The latter is connected through a buffer amplifier to a gain control unit. The outputs of the gain control units of the three channels are connected through switches to a summer, whose output is applied to a display screen such as an oscilloscope. The switches select the output of one or a combination of the channels to the summer. The phase control and input unit of each channel synchronize the start of the sawtooth voltage with the exponentially damped sine wave generated by the LCR unit.

The inductance of the gated LCR unit is adjustable to provide frequency range selectivity; the capacitance is adjustable for fine frequency tuning; and the resistance is adjustable for controlling the damping factor of the exponentially damped sine wave.

The amplitude of the wave envelope produced by each channel is controlled by its corresponding gain control unit. Thus, each channel includes controls for the frequency, amplitude, damping factor, and phase of its exponentially damped sine wave with respect to the sine waves generated in the other units.

The basic method can be used to generate a complex curve whose component parts are other than exponentially damped sine waves. The simulator can be thought of as an instrument designed to produce a complex waveform to match a complex waveform generated in an experiment or a scientific application, where the simulated waveform consists of a plurality of components. The parameters of each of the components can be adjusted until the complex waveform matches the experimentally produced curve.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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